The IN-mode in the TCV tokamak

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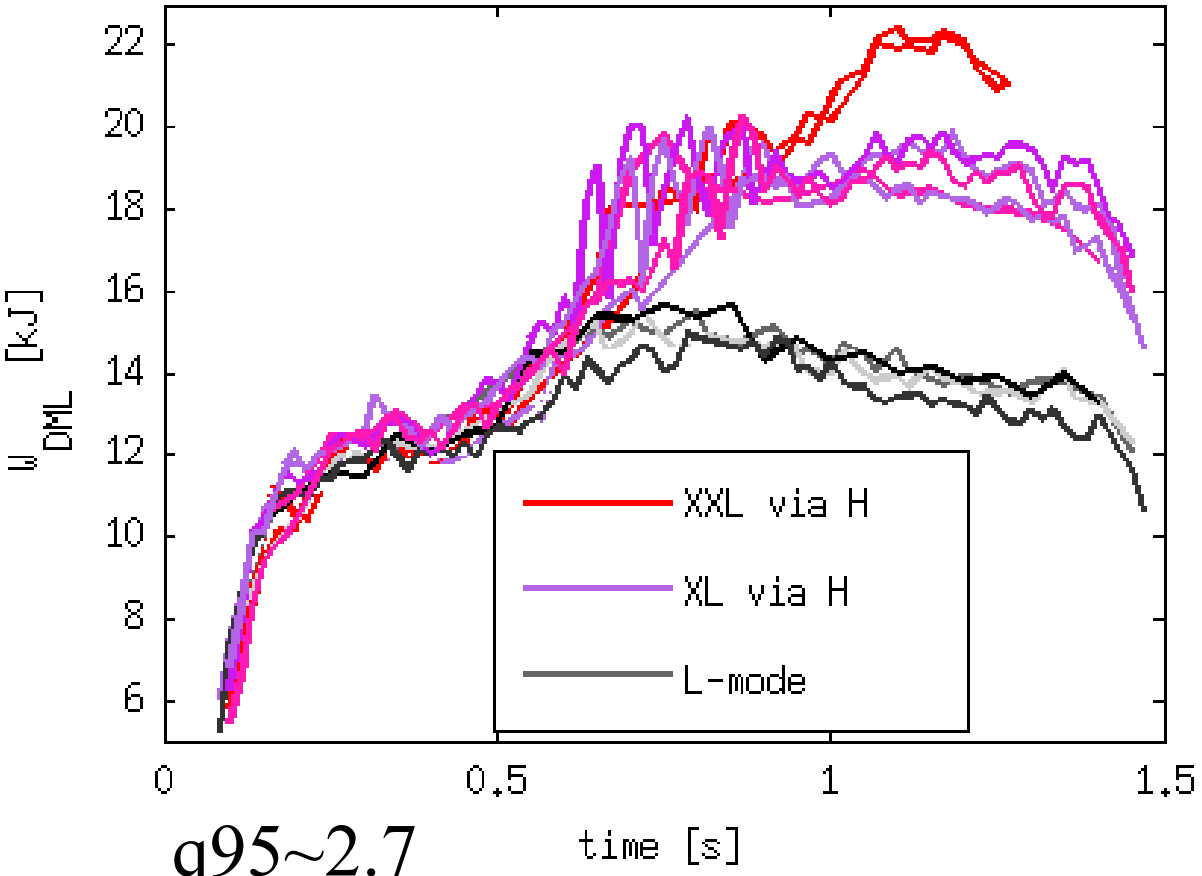
Outline

- High L-mode confinement in ohmic TCV shots
- Proximity to L-H transition
- Role of density in early phase of the discharge
- Comparison with H-mode profiles
- Similarity of core profiles, role of edge properties
- Conclusions

High L-mode confinement in ohmic TCV shots



q95~2.7

κ~1.5

Ip~320kA, β_N~1.4

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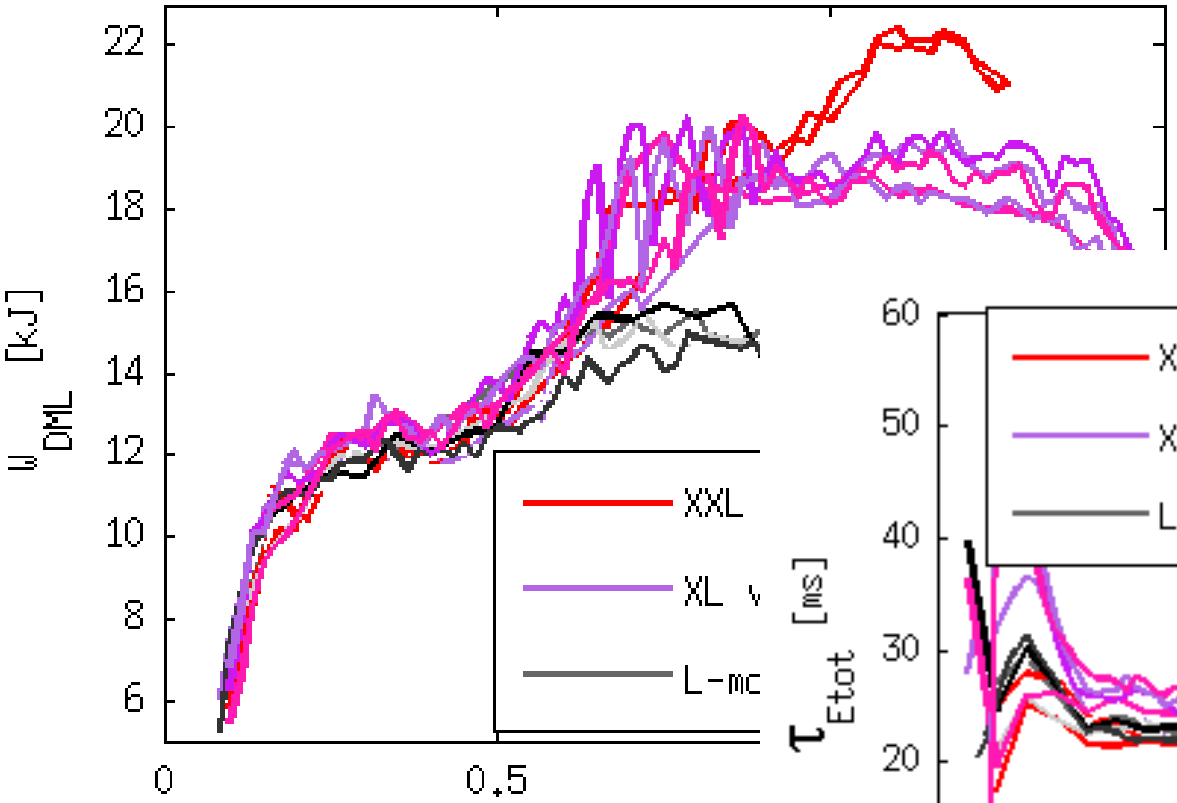

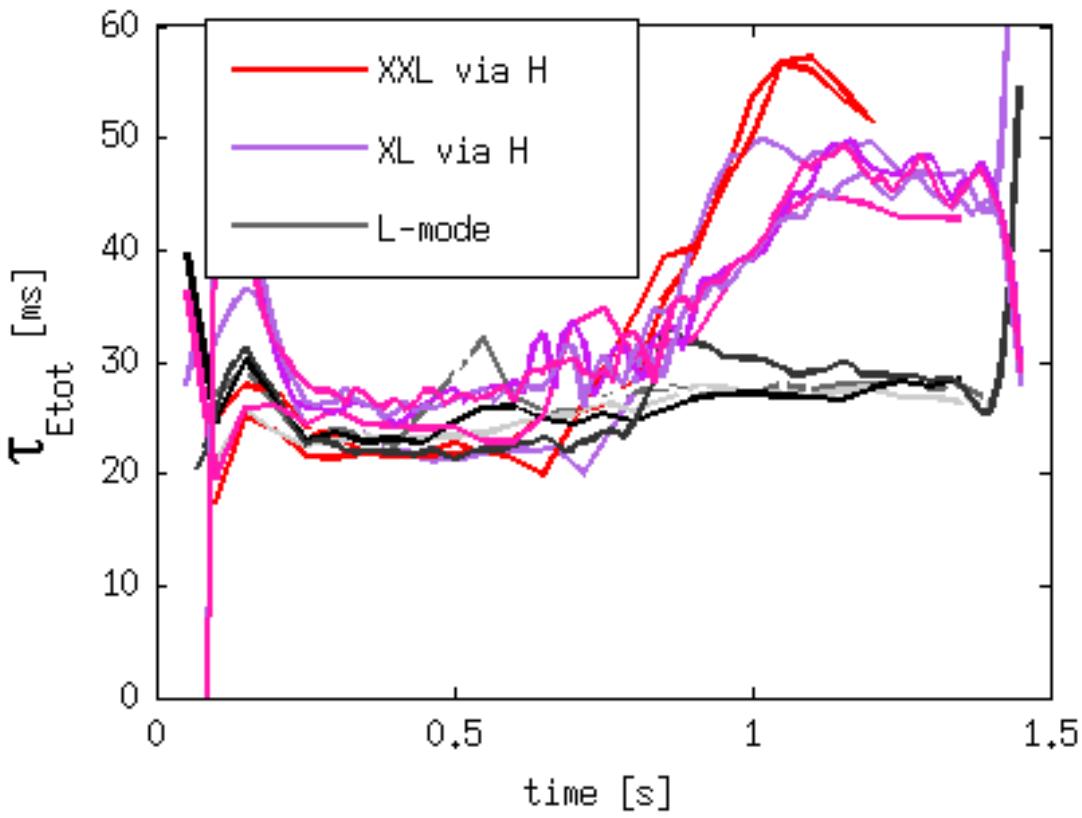

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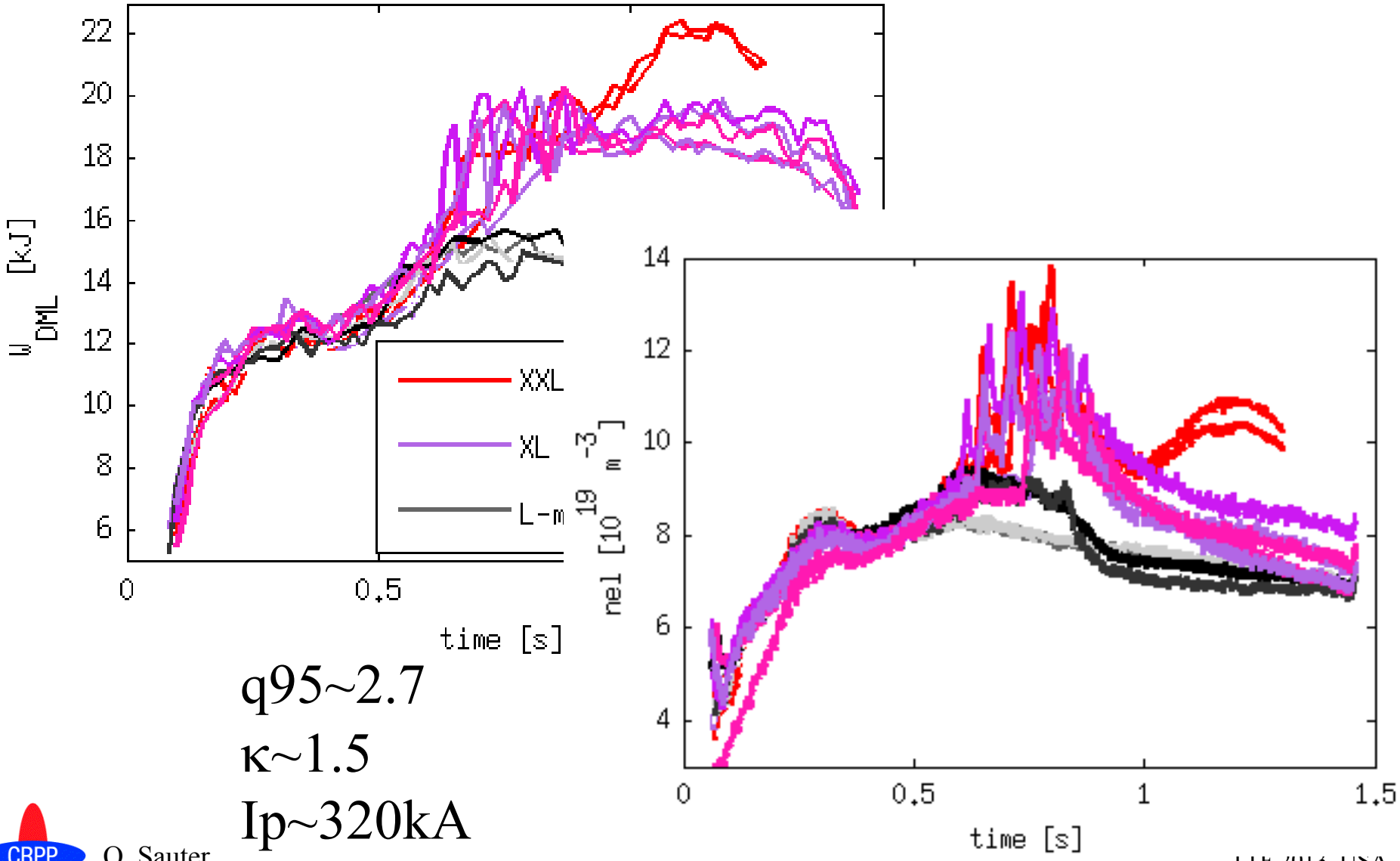

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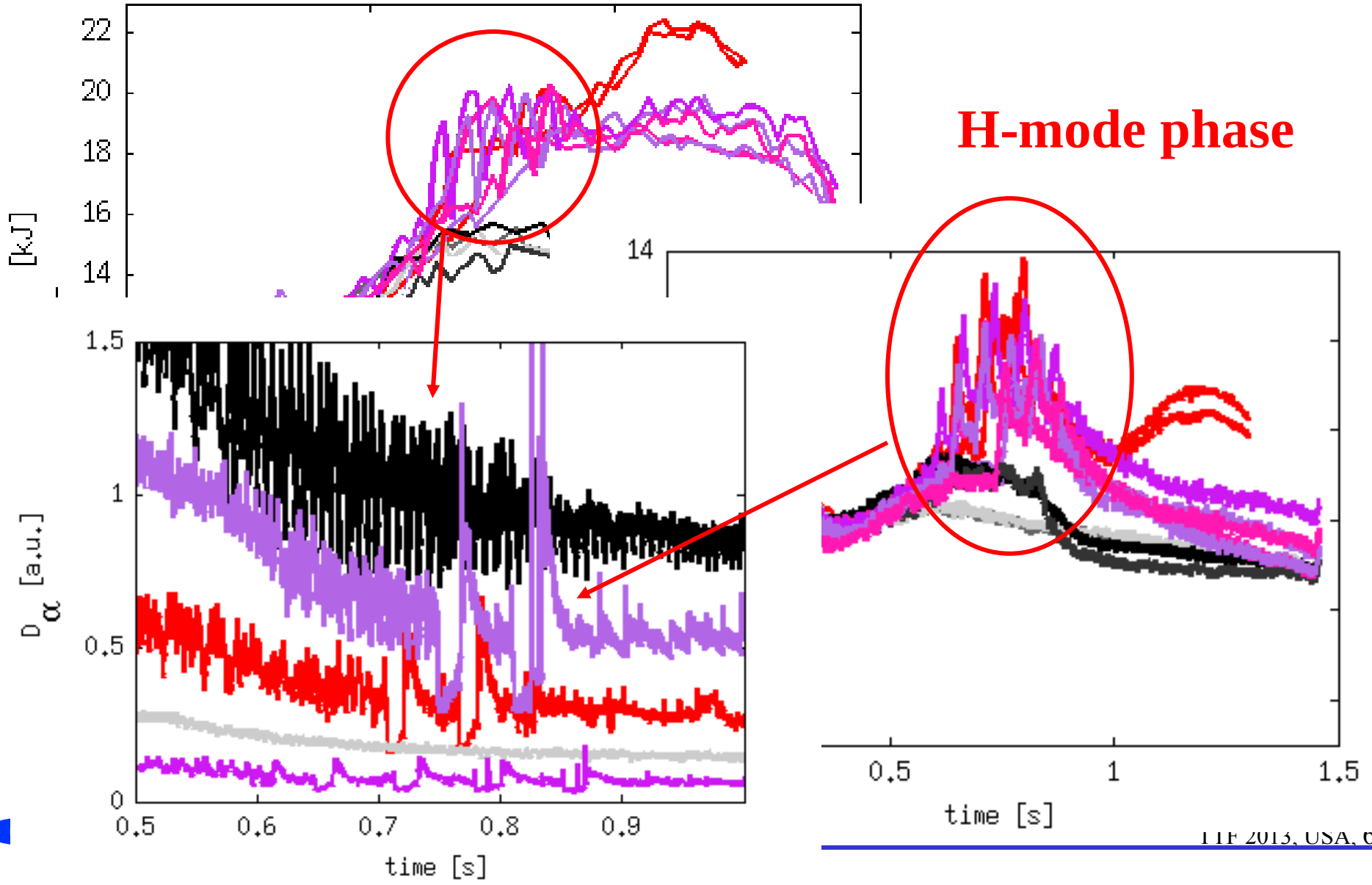
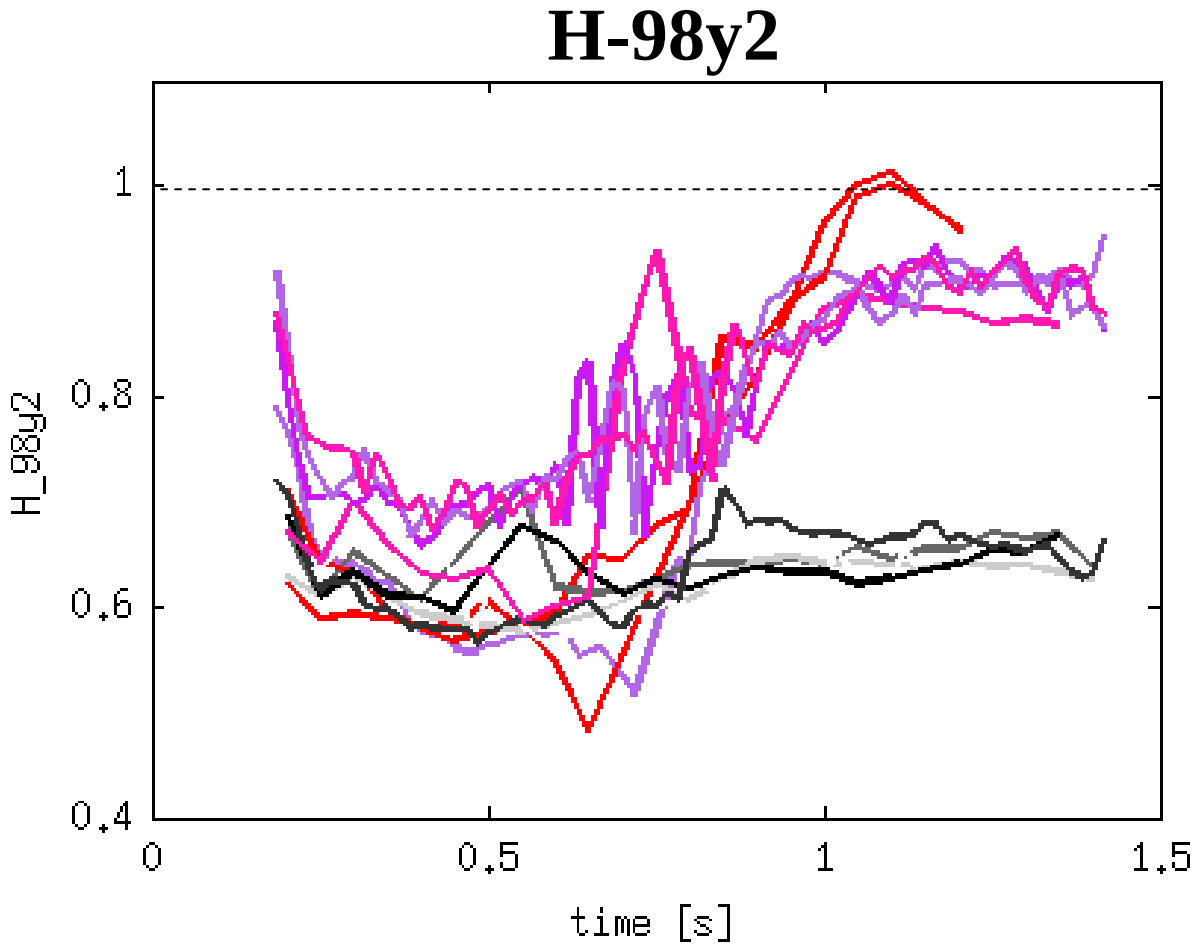


Improved L-mode Thanks to H-mode phase



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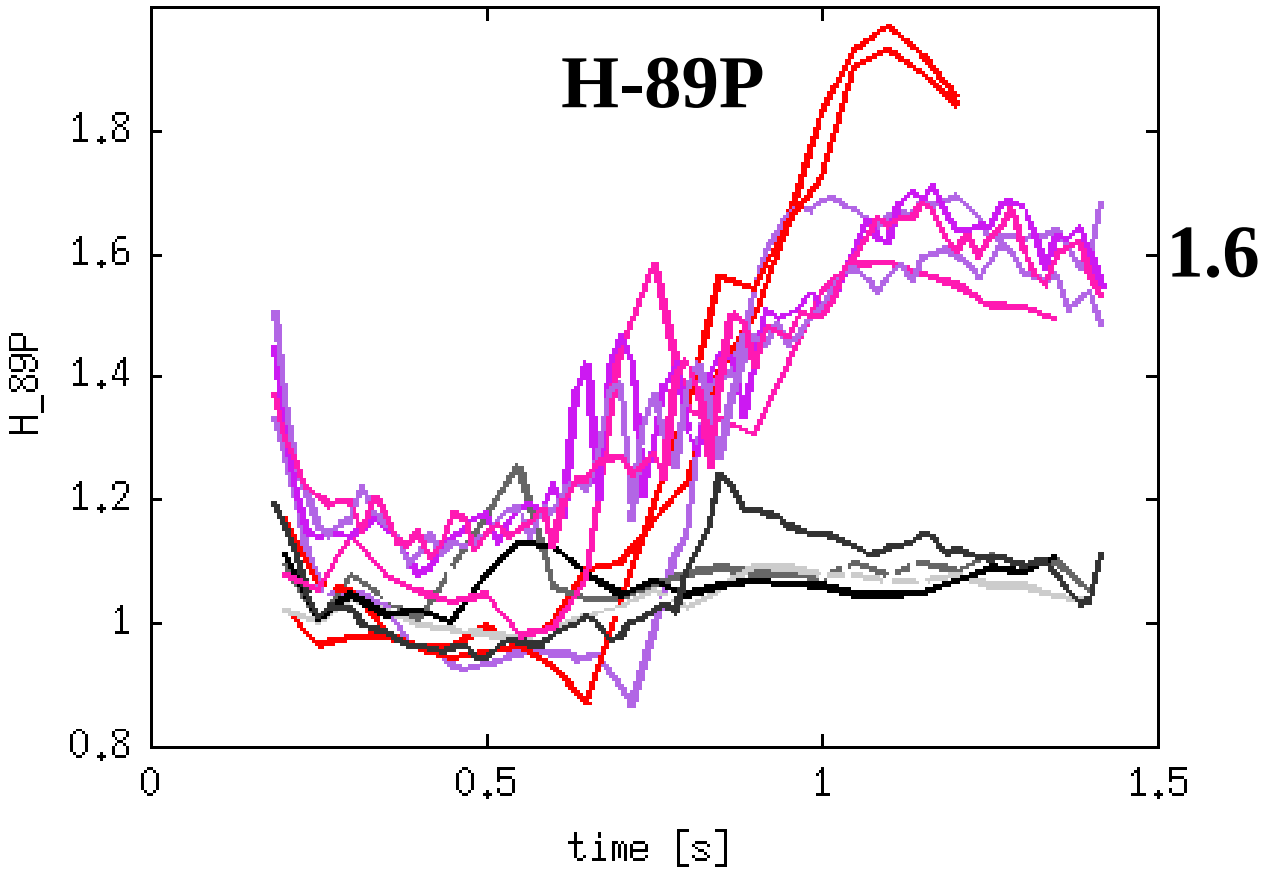
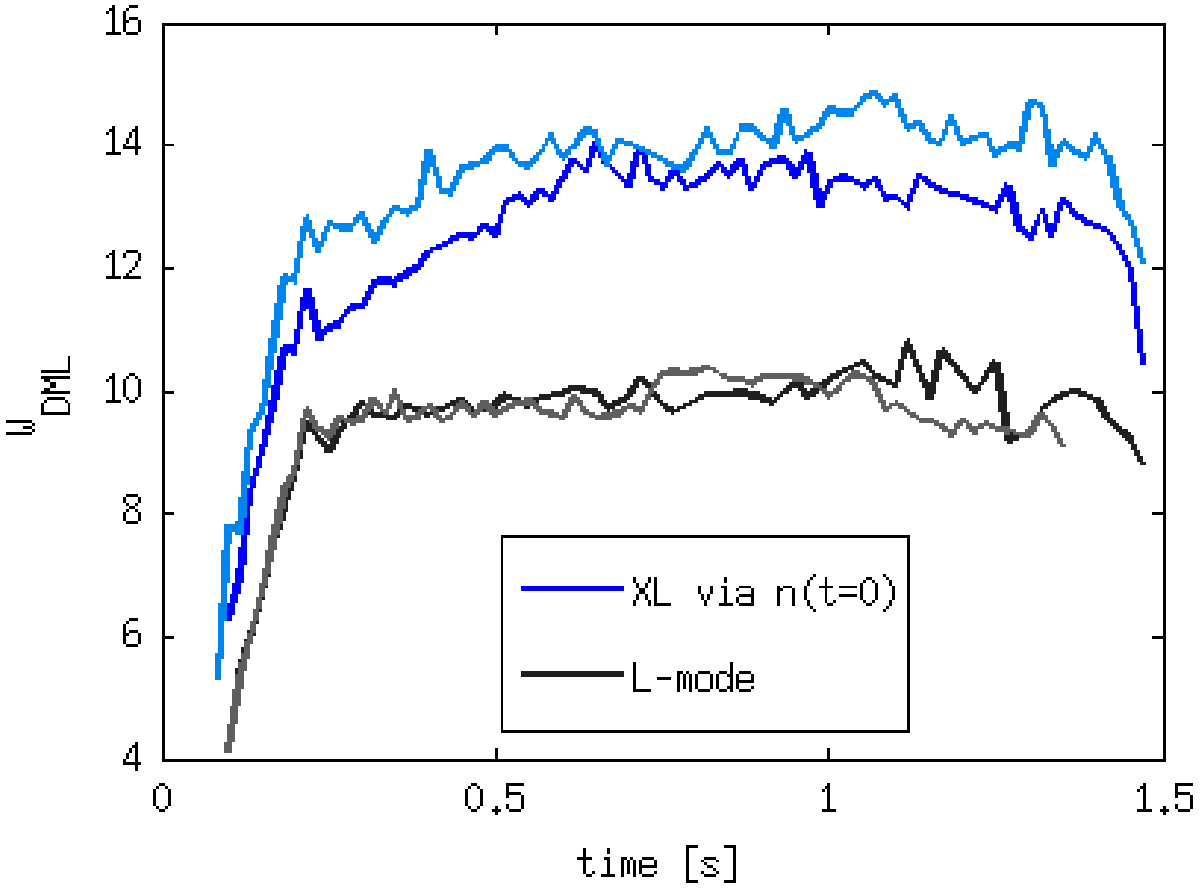


1.6

Through H-mode phase: normal to high L-mode conf.

Without H-mode phase at lower Ip



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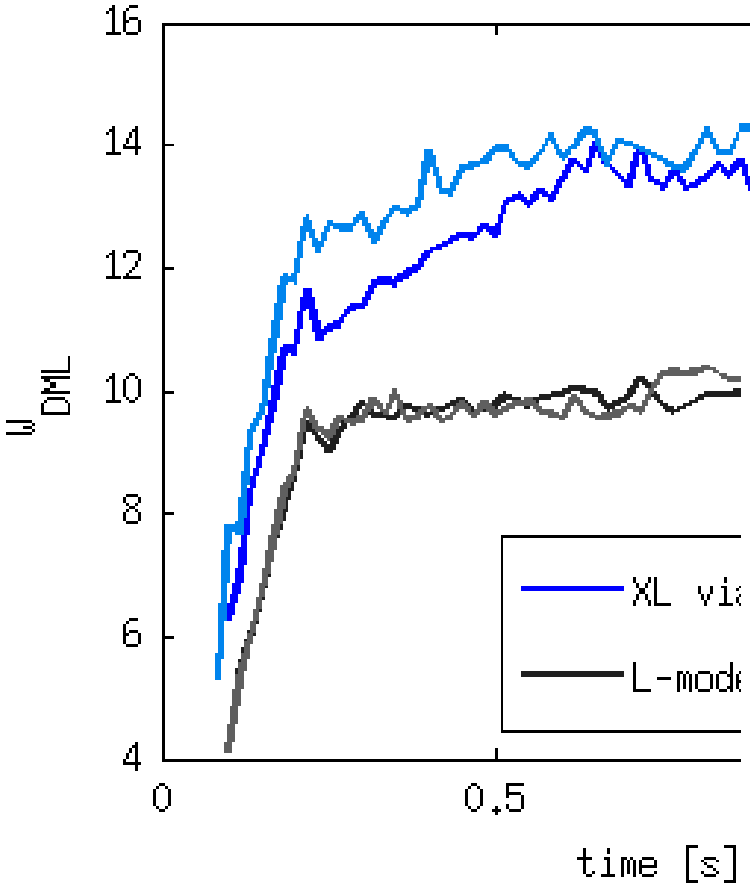

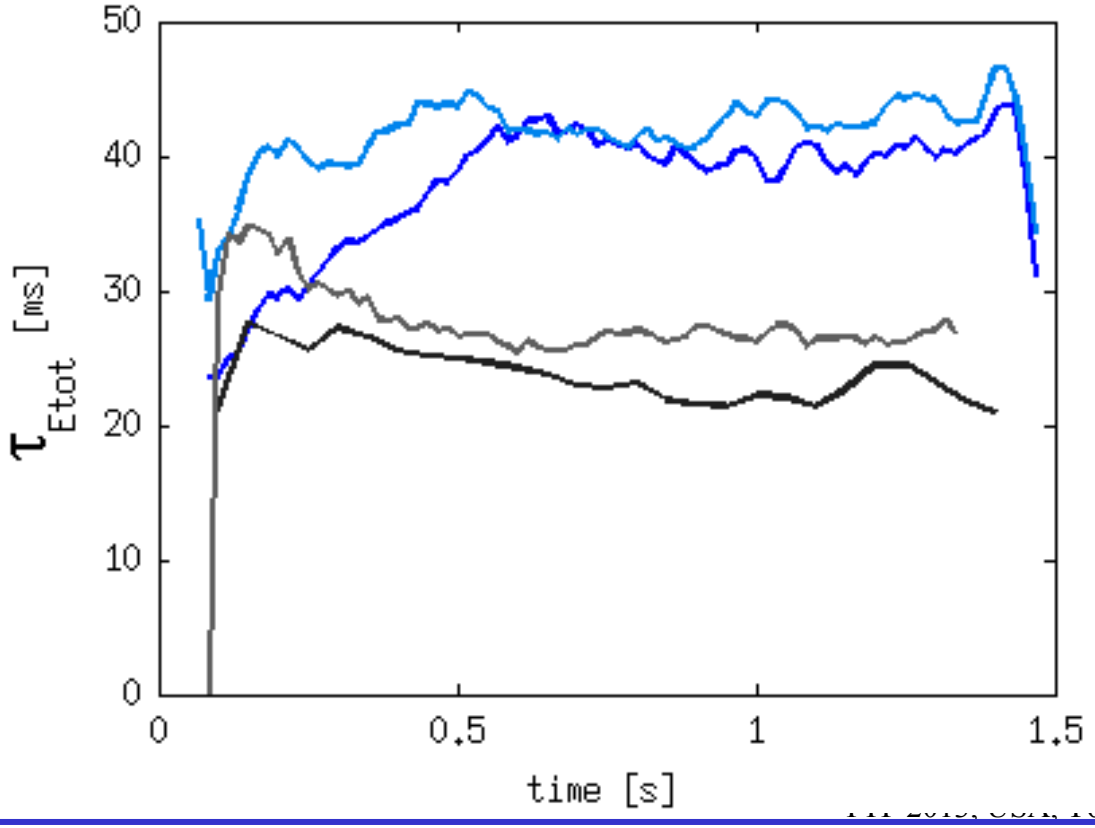

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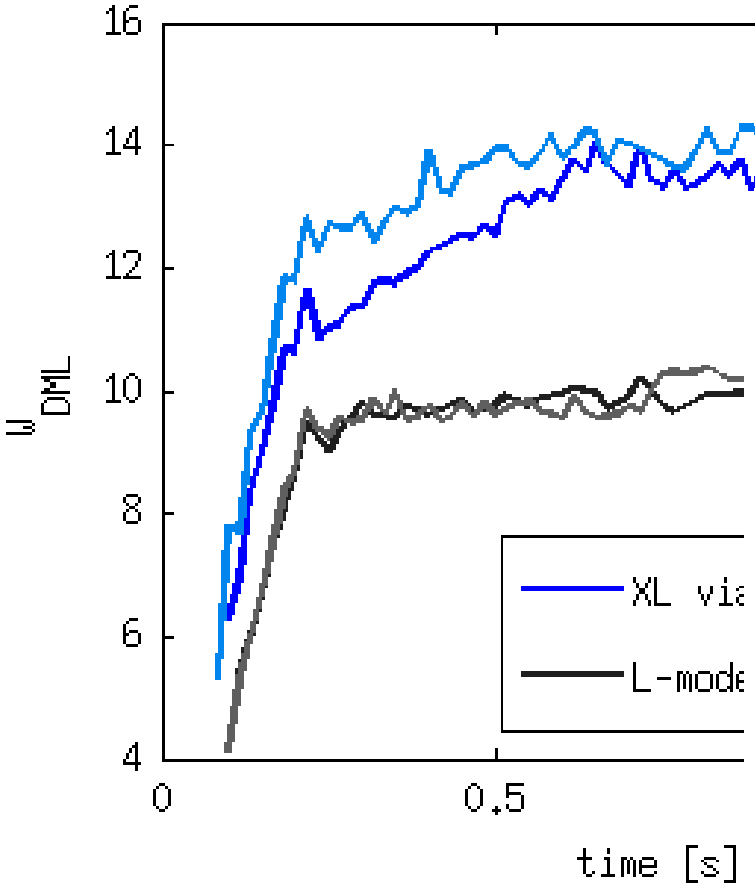

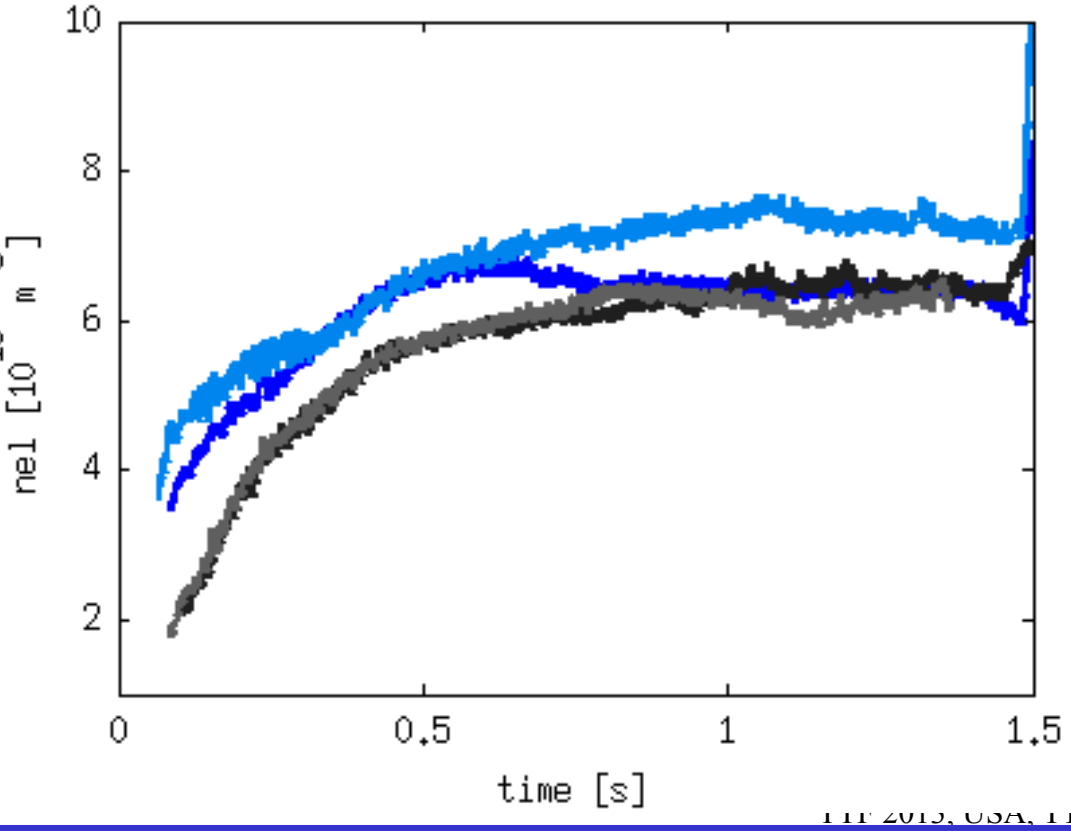

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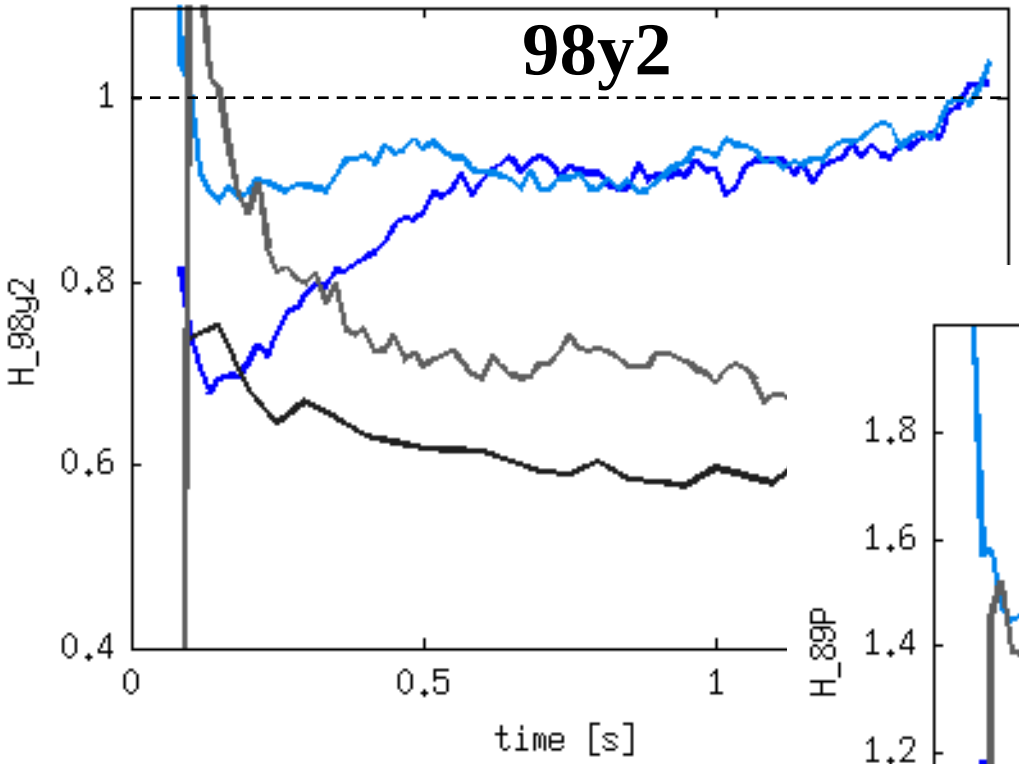
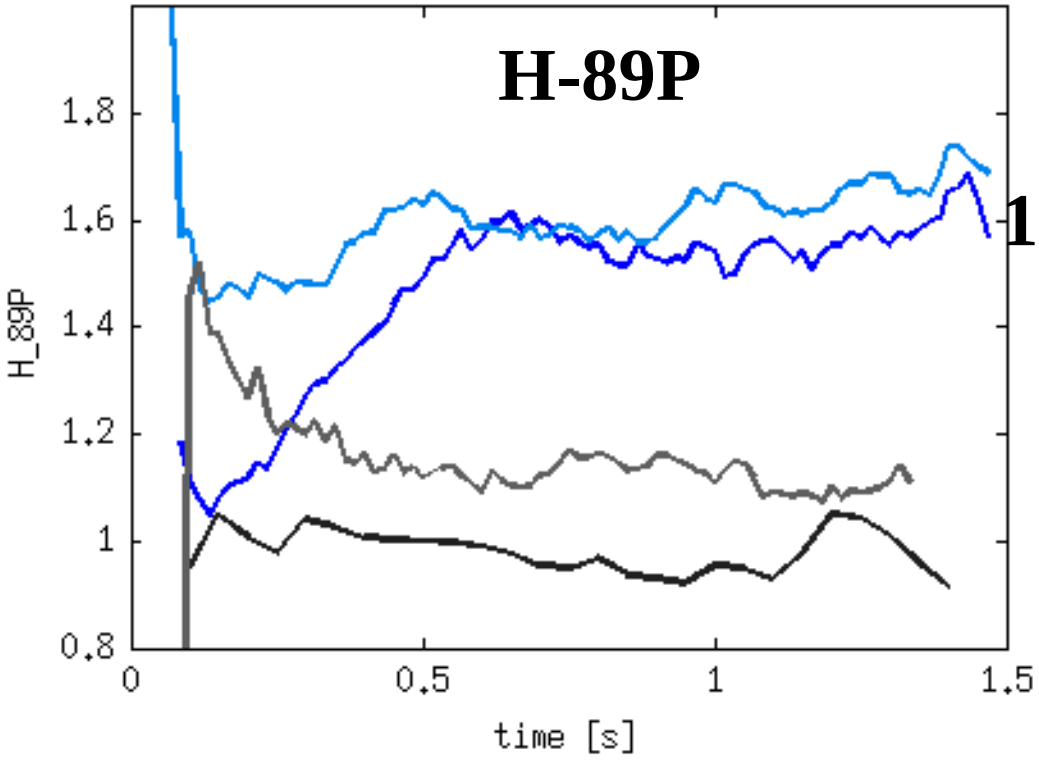
Without H-mode phase at lower Ip:
similar H-factors: L-mode with $H_{98y2} \approx 0.9$





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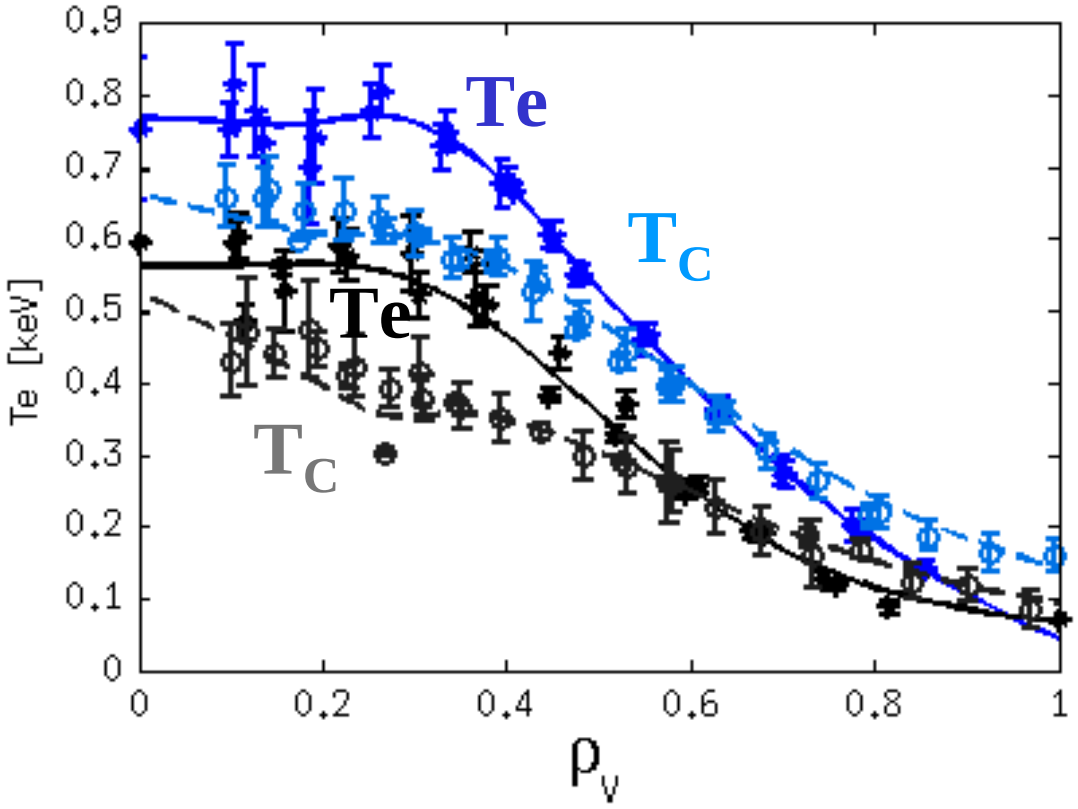
T_e, T_i in low I_p IN-mode: T_e~T_i (high n_e)



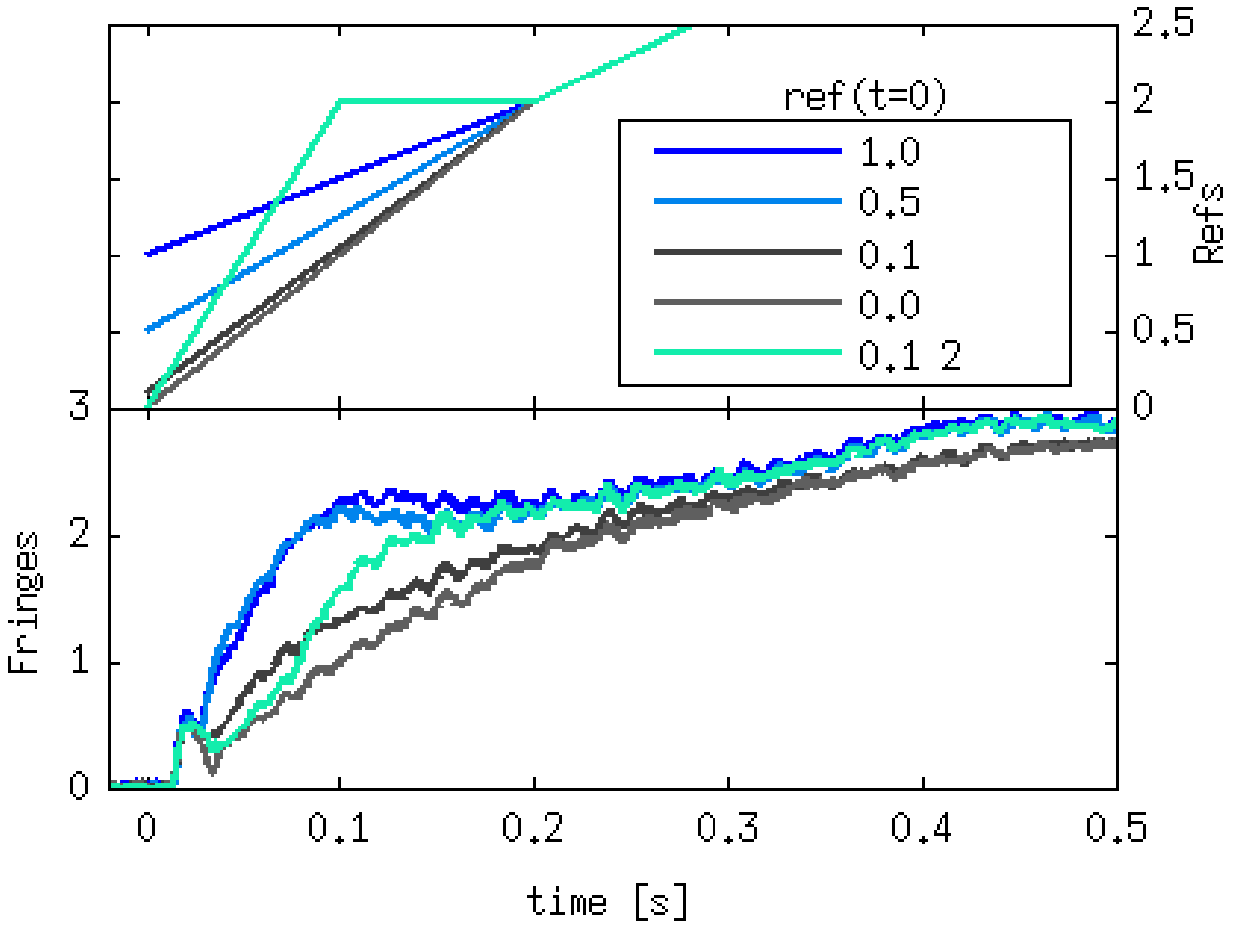
I_p=260kA, n_{el}=6.3e19

45870: (W_{dml}=13.5)
We=7.0kJ
Wi=5.5kJ

46178: (W_{dml}=10)
We=4.5kJ
Wi=4.0kJ

- Both Te and Ti improve
- Ti > Te in edge region
- Density profiles are similar (n_{el} control)

Without H-mode phase: Importance of early density reference



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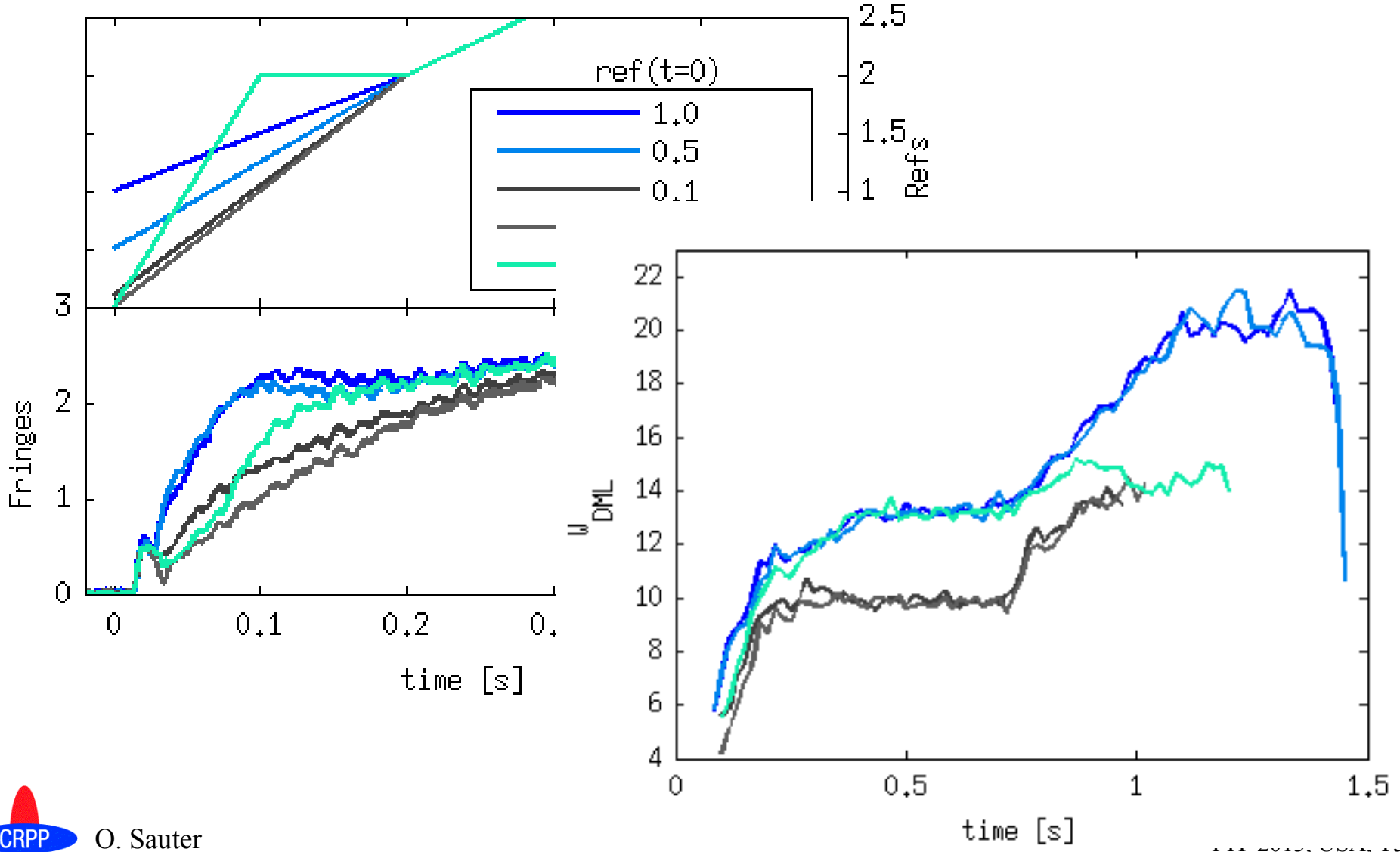

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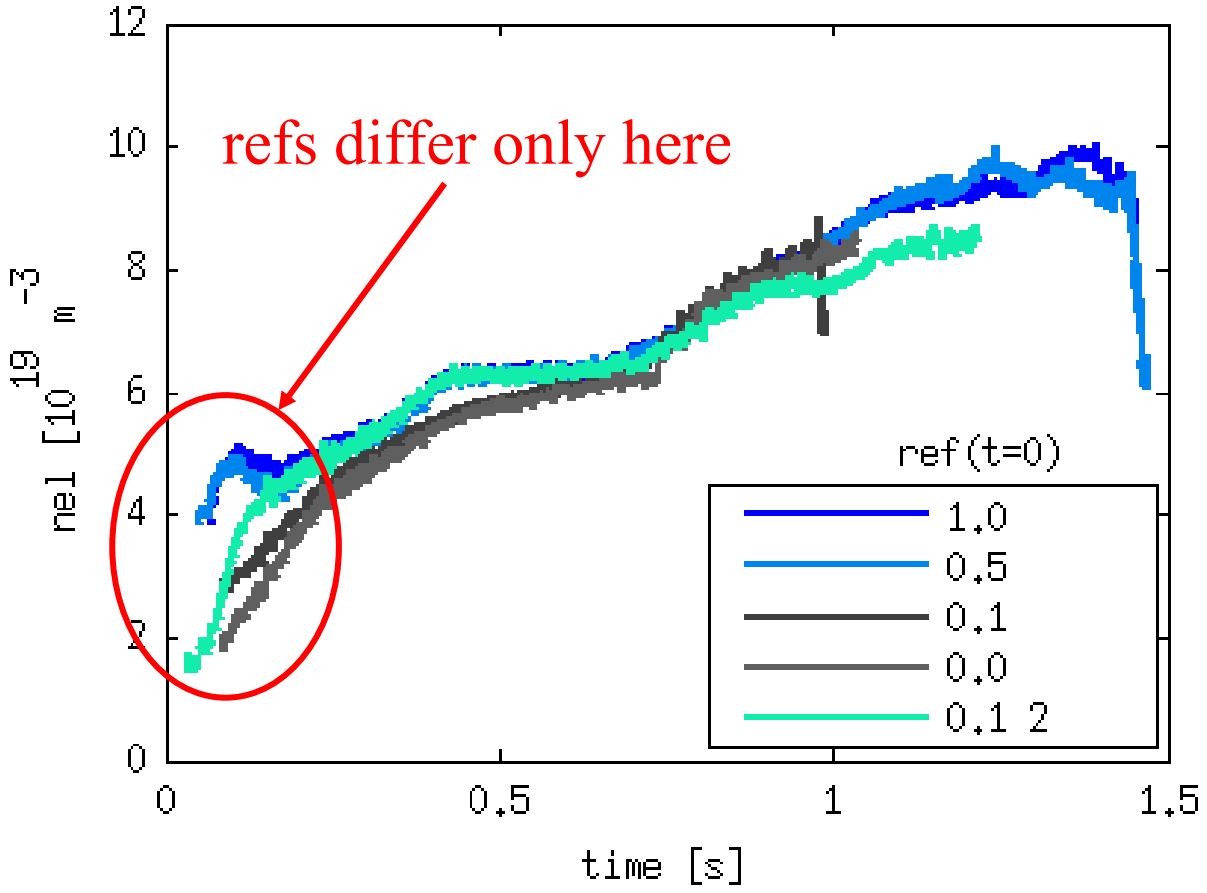

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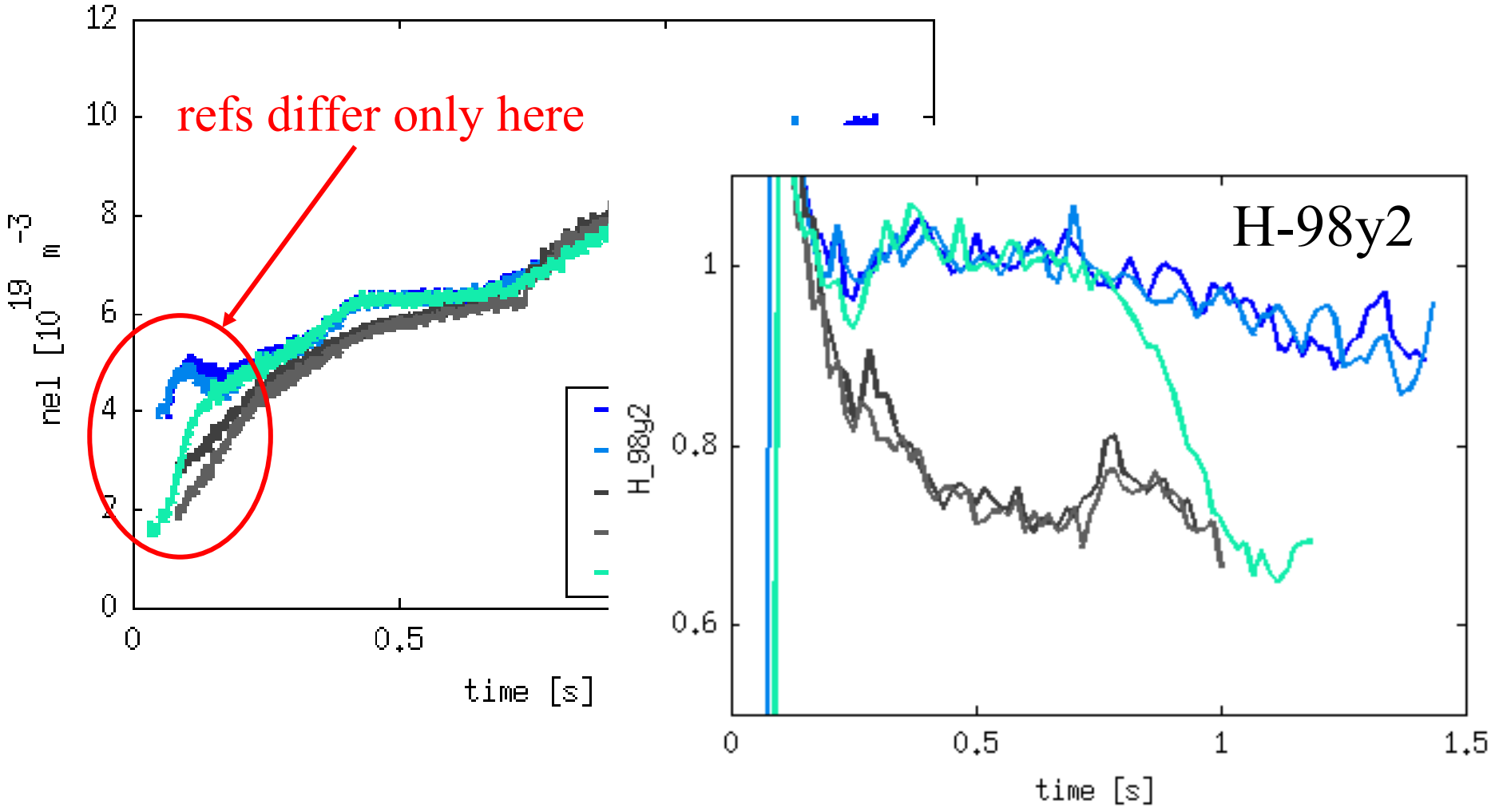

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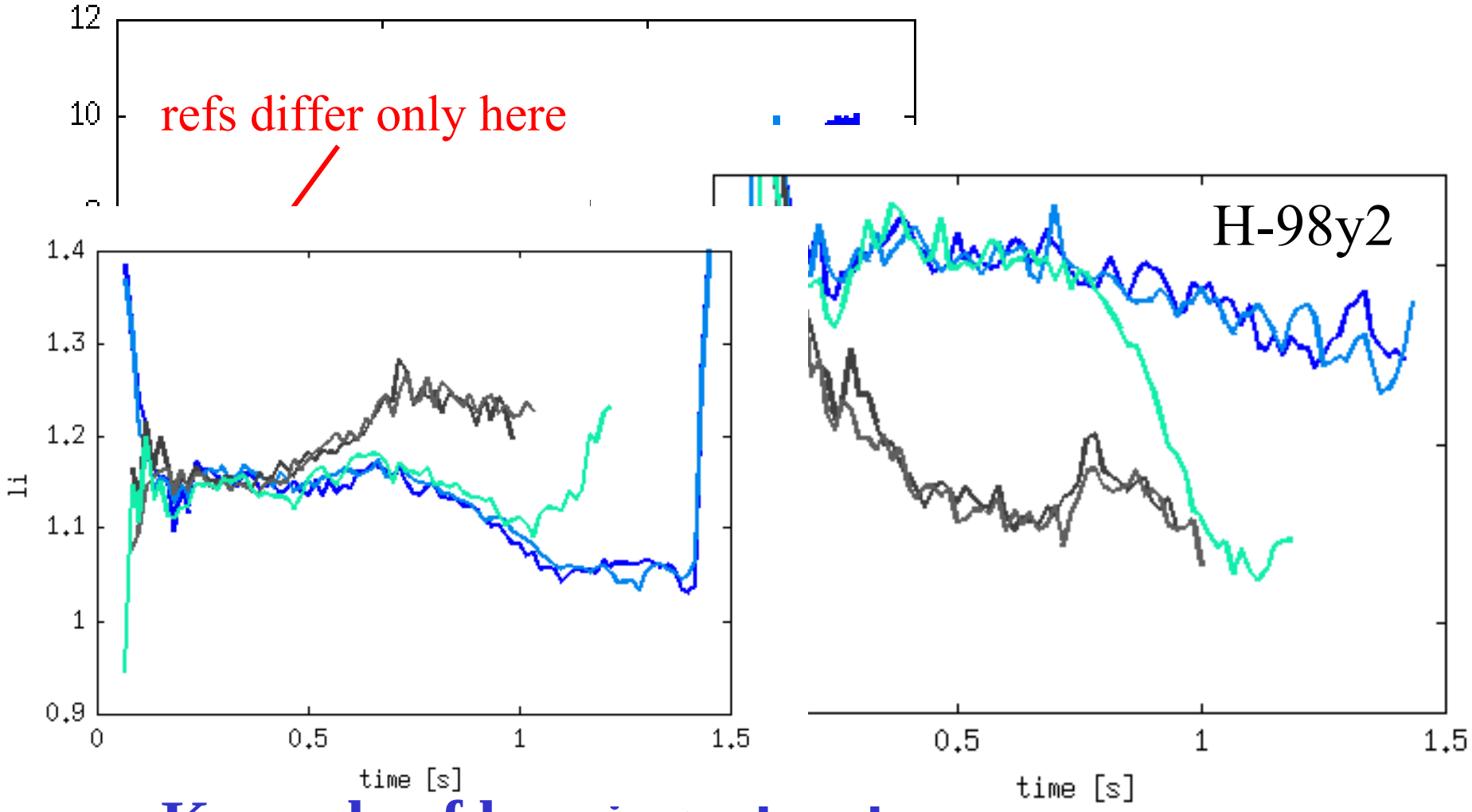
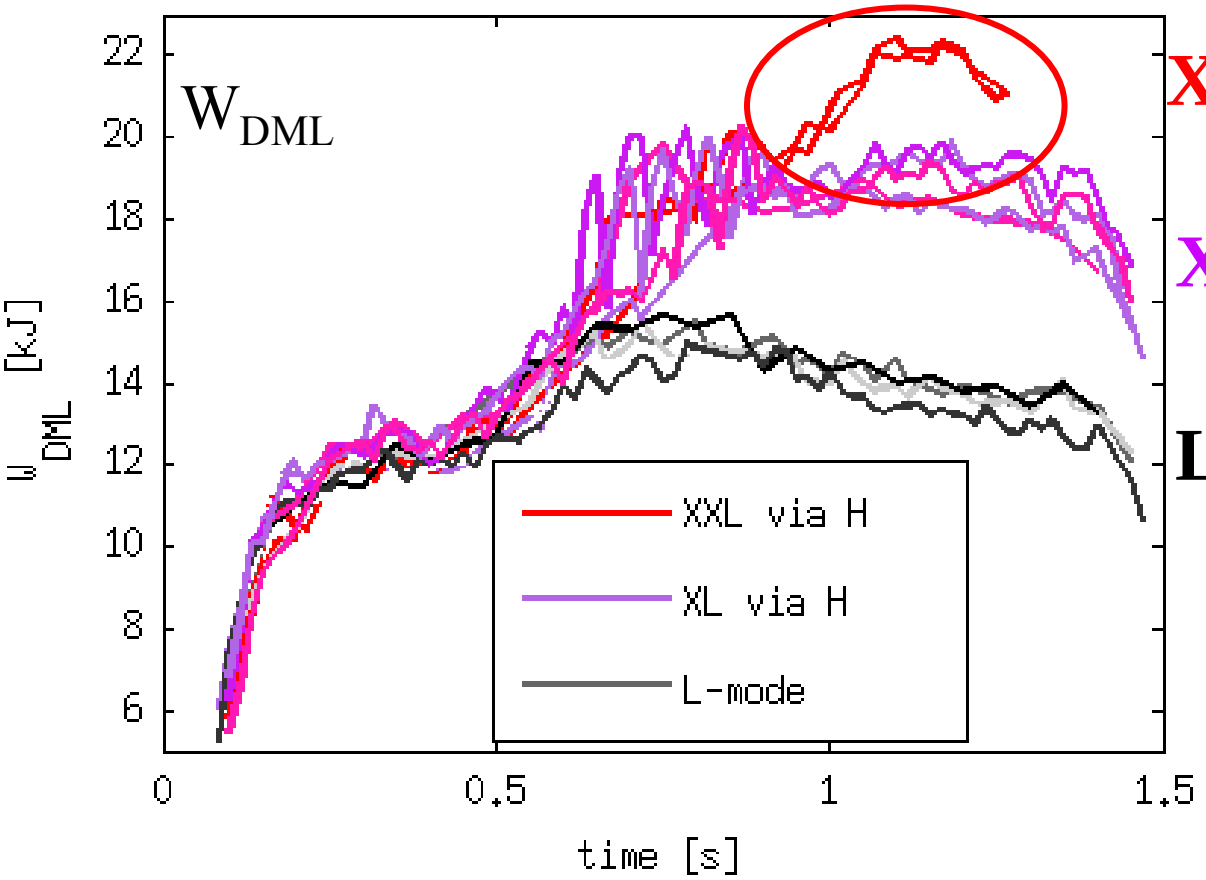


Key role of keeping a low l_i

Back to high L-mode conf. via H-mode phase

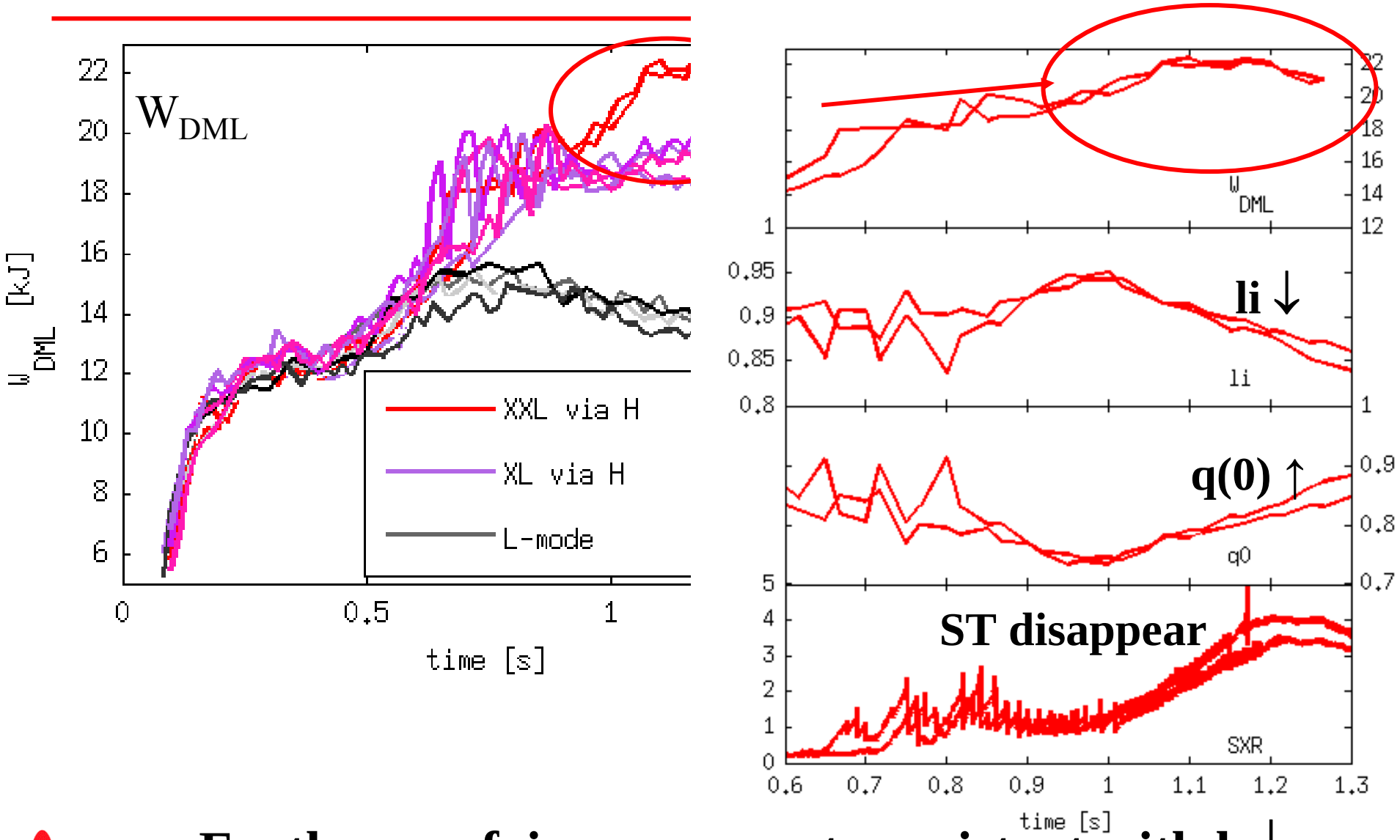


XXL-mode

XL-mode

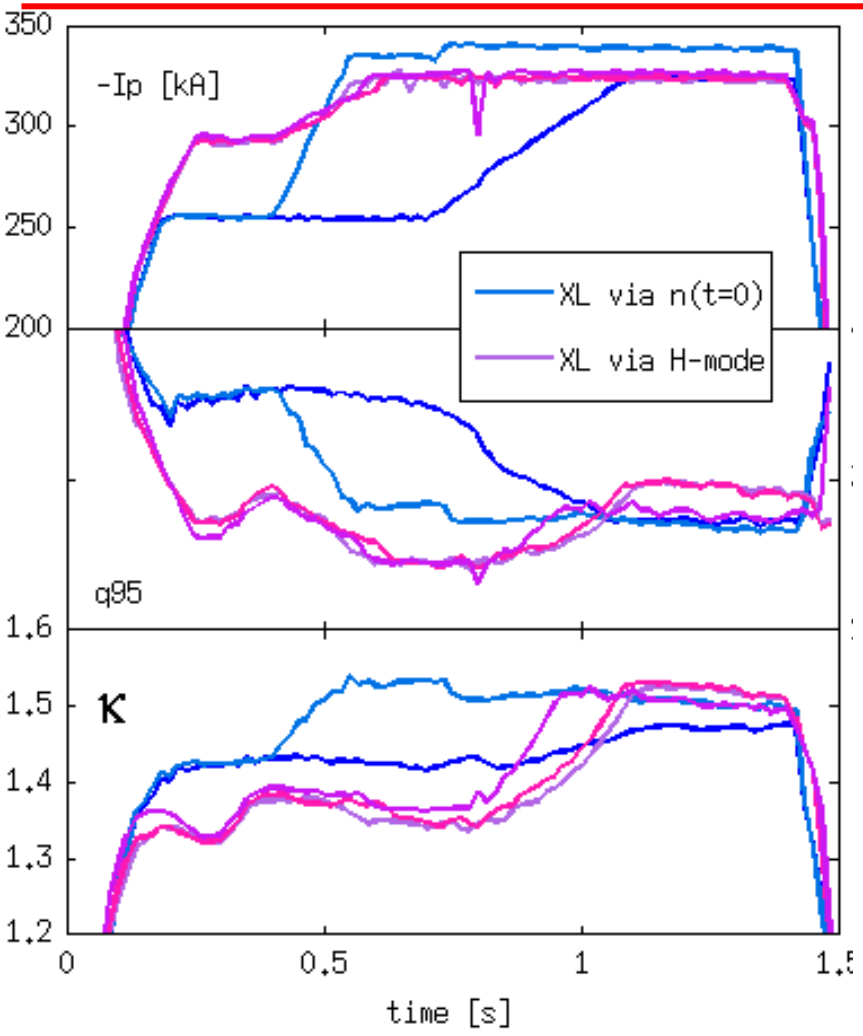
L-mode

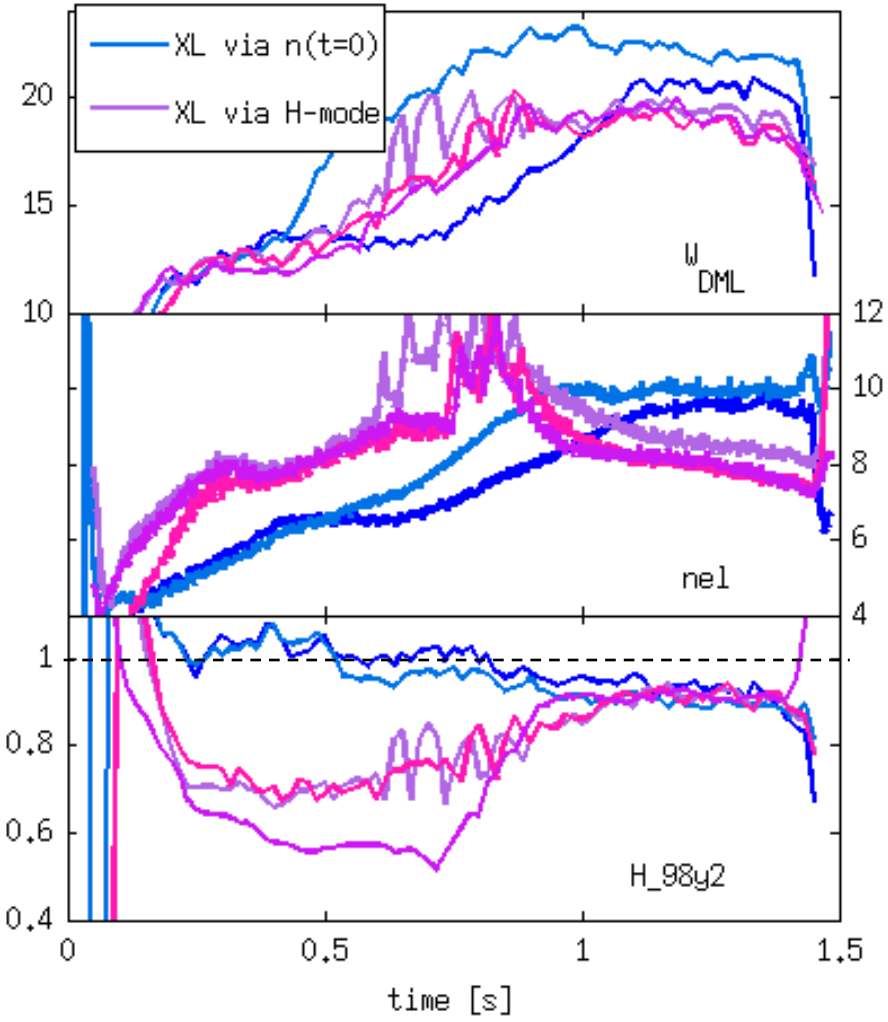
Back to high L-mode conf. via H-mode phase



Further conf. improvement consistent with l_i ↓

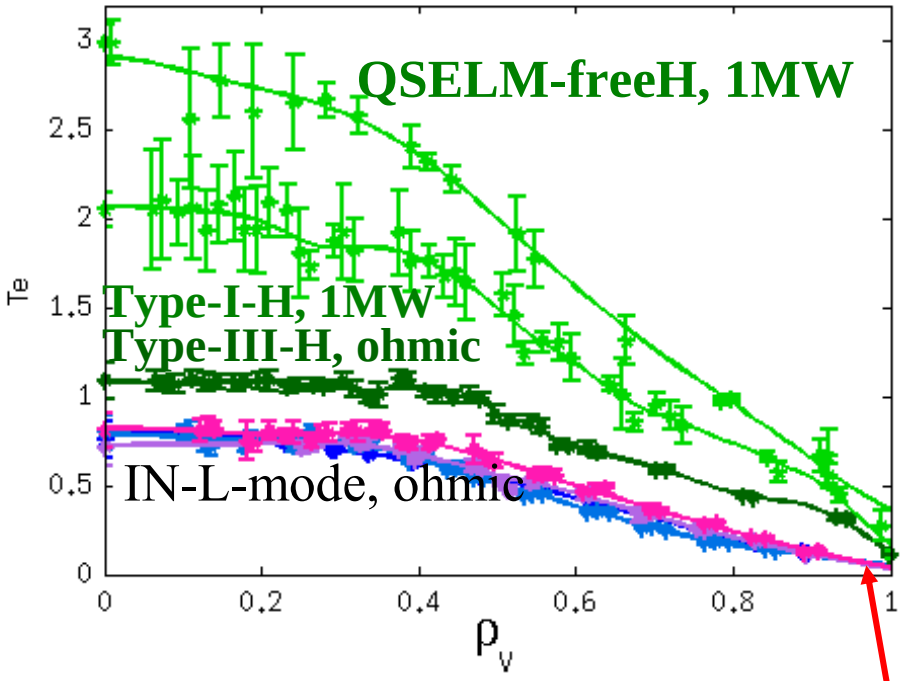
Aiming at same final high parameters

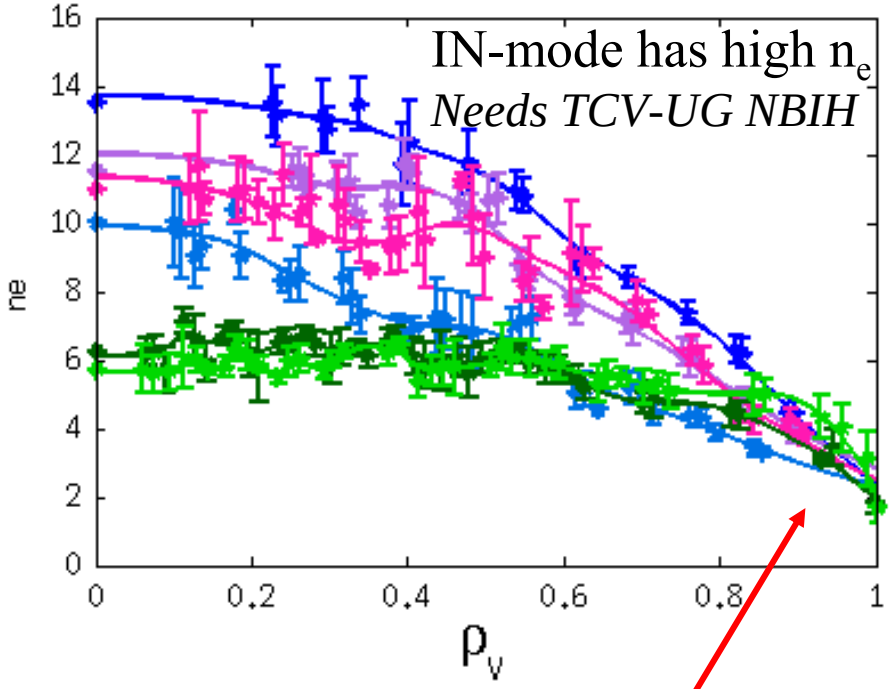




Can reach high ohmic L-mode perf. with both approach

Comparison with H-mode profiles

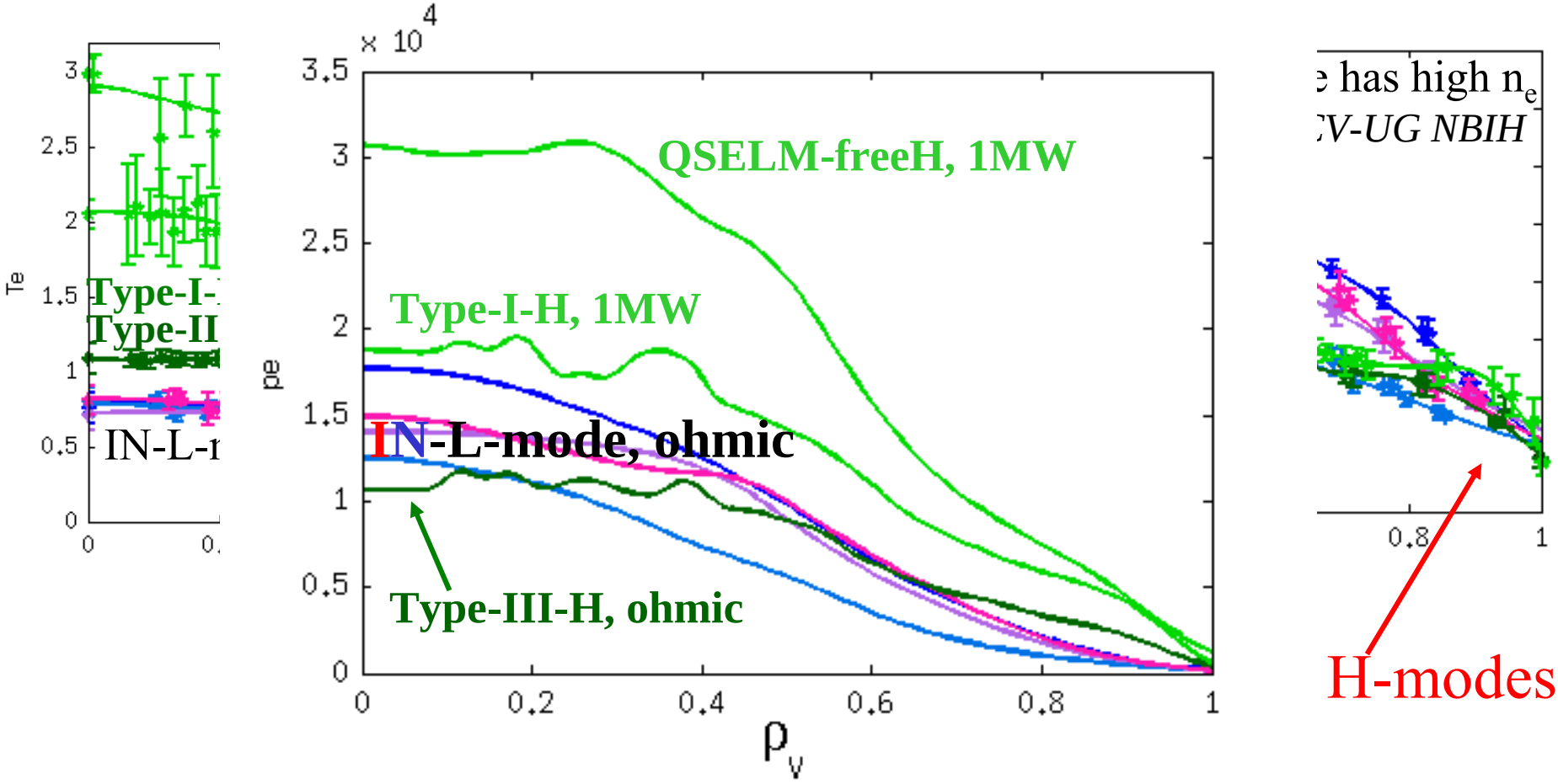




- edge ne in IN-mode similar to H-modes
- not edge Te

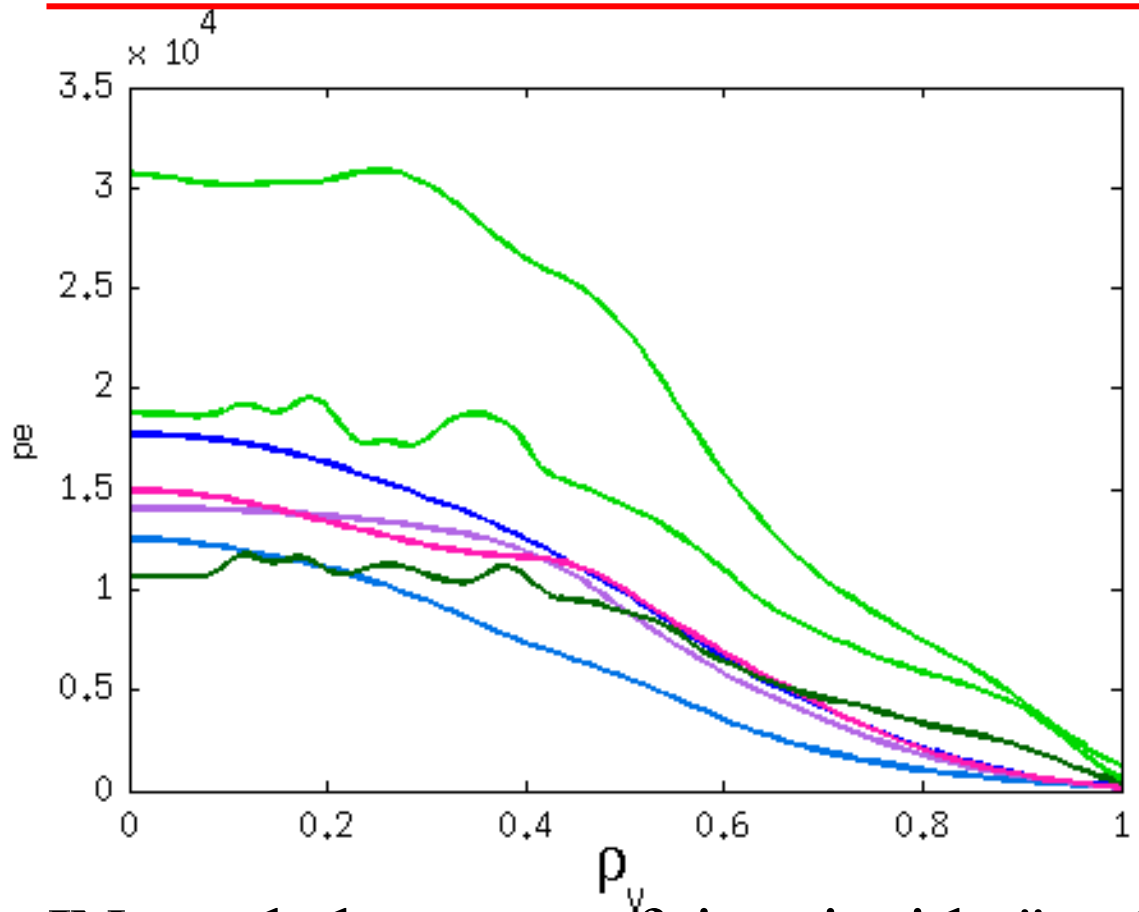
L. Porte et al Nucl. Fusion **47** (2007) 952
A. Pitzshke et al PPCF **54** (2012) 015007

Comparison with H-mode profiles



- IN-L-mode in TCV close to H-mode profiles
- Fills in H-mode range of profiles 0.5-1.5MW

IN-mode and H-mode profiles are ~self-similar



- IN-mode better conf. just inside "pedestal"? (+$n_e(\rho=1)$)
- Edge L-modes are not stiff => wide variety of scenarios

On the non-stiffness of edge transport in L-modes, O. Sauter et al, TTF2013

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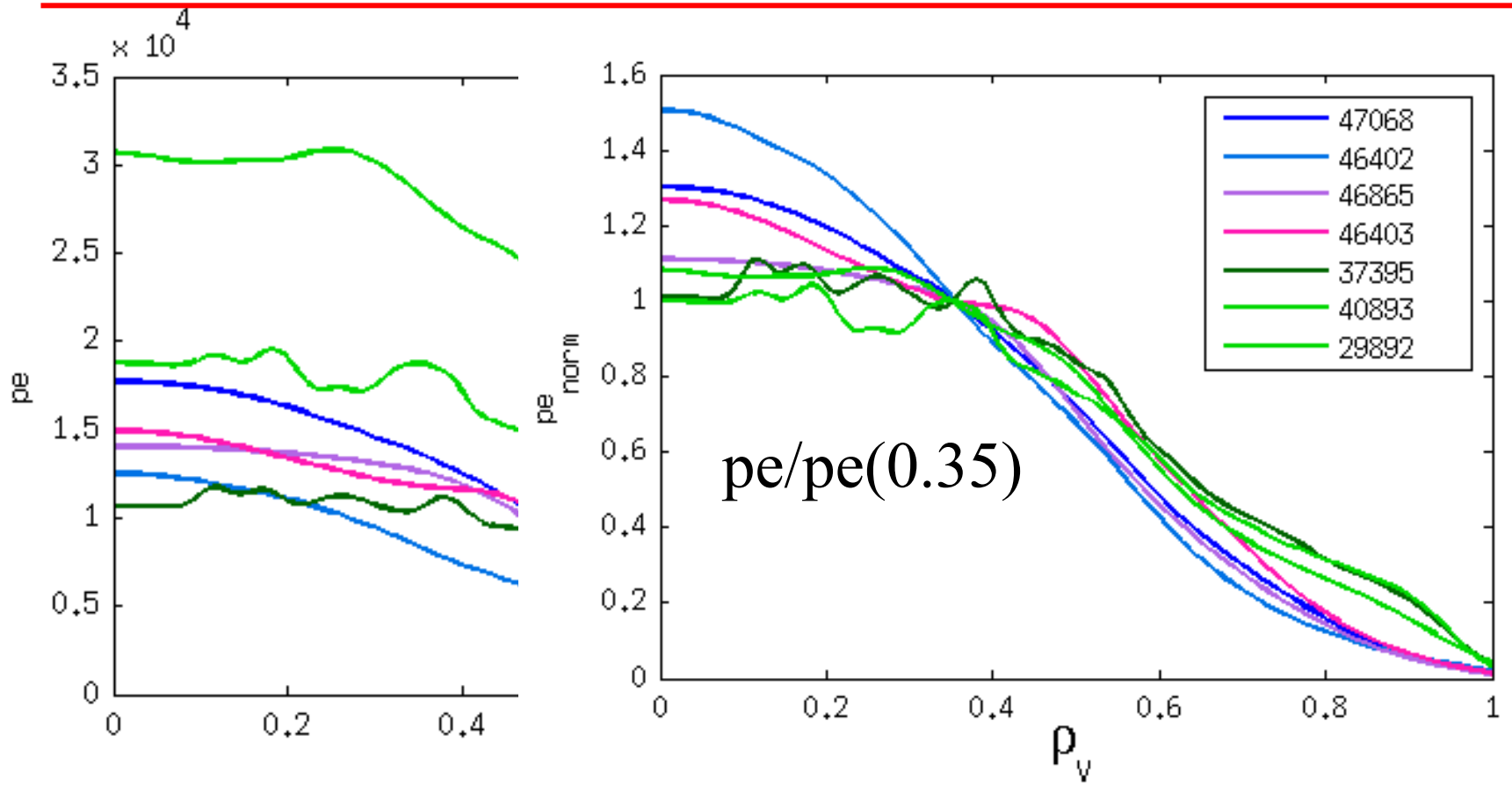

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Conclusions

- IN-mode is "another" improved L-mode
- IN-mode reached H_{98y}~0.9-1 in stationary ohmic L-mode
- It has low edge Te (<100eV) and relatively high edge ne
- A) Limited H-modes was triggered when forming IN-mode
- B) High n_e request from t=0 helped creating IN-mode
- In both A and B series, li is lower with good confinement
- With both A, B series, similar paremeters were obtained
- Stationary improved confinement does not depend on initial conditions but needed to "create" good confinement
- It shows that L-modes can have a very wide range of edge and core profiles: namely "I-family" *(edge non-stiff)*